Effects of alcohol on the fetus: impact and prevention

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In the spectrum of adverse effects on the fetus or infant associated with maternal drinking during pregnancy the most dramatic is the fetal alcohol syndrome, a pattern of malformation that has been associated with maternal alcohol abuse. Other undesirable outcomes of pregnancy linked to alcohol exposure in utero include growth deficiency, major and minor anomalies, decrements in mental and motor performance, and fetal and perinatal wastage. Alcohol, like other teratogens, does not uniformly affect all those exposed to it. Rather, there seems to be a continuum of effects of alcohol on the fetus with increasingly severe outcomes generally associated with higher intakes of alcohol by the mother.

The cost of fetal damage associated with alcohol exposure is very high. A program to decrease the incidence of fetal alcohol effects is therefore imperative. The cornerstone of such a program must be not only education of the public but also careful training of all professionals who provide health care for pregnant women.

De l'ensemble des effets secondaires pour le foetus ou le nouveau-né reliés à l'alcoolisme maternel durant la grossesse, le plus dramatique est le syndrome alcoolique foetal, un tableau de malformations qui a été reliés à l'abus de l'alcool chez la mère. Les autres résultats indésirables reliés à une exposition in utero à l'alcool comprennent un retard de croissance, des anomalies majeures et mineures, une baisse des performances mentales et motrices, et la mort prénatal ou périnatal. L'alcool, comme d'autres tératogènes, ne touche pas uniformément tous ceux qui y sont exposés. Il semble plutôt y avoir une continuité des effets de l'alcool sur le foetus, les résultats les plus graves étant généralement associés à une plus forte consommation d'alcool chez la mère.

Le coût résultant des dommages causés au foetus par l'exposition à l'alcool est très élevé. Il devient donc impérieux de mettre sur pied un programme visant à réduire la fréquence des effets de l'alcool chez le foetus. La pierre angulaire d'un tel programme ne doit pas reposer uniquement sur l'éducation du public, mais également sur une solide formation de tous les professionnels qui donnent des soins aux femmes enceintes.

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This paper will describe adverse effects on the fetus or infant associated with both maternal alcohol abuse and with drinking at more moderate levels during pregnancy, and consider the magnitude of these effects in childbearing women. Strategies for preventing these effects of alcohol on the fetus and for intervening to reduce alcohol abuse by women during pregnancy will also be presented.

Impact of intrauterine exposure to alcohol

Fetal alcohol syndrome

Alcohol abuse by women during pregnancy is associated with a syndrome of growth deficiency, altered morphogenesis and mental retardation in their offspring that has been termed the fetal alcohol syndrome.[1-3] Over 450 cases have been described in the medical literature from many countries.[4] The syndrome has been described in all races and at ages ranging from neonatal to young adult.

Severe prenatal and postnatal growth deficiency characterizes most children with the syndrome. The characteristic dysmorphic features have been fully described elsewhere.[3] They include short palpebral fissures, a thin upper lip, a hypoplastic philtrum and a flat nasal bridge, as well as eye and ear anomalies and heart defects. A variety of other minor and major malformations occur with varying frequency in affected persons, but no specific major malformations are diagnostic.[3] Comparable data from three countries on the results of standardized intelligence quotient (IQ) tests given to children with the fetal alcohol syndrome support the conclusion that these children have various degrees of intellectual handicap.[5-7] The average IQ of children with this syndrome is around 68, or mildly retarded. However, the range of scores is very wide — 16 to 105 in one sample of 20 cases.[7] A positive relation has also been reported between severity of physical manifestations and IQ:[5-7] children with the greatest growth deficiency and altered morphogenesis tend to have the poorest intellectual development.

Fetal alcohol effects

The risk of fetal alcohol syndrome is not the only risk to children conceived by alcoholic mothers. Significantly higher perinatal mortality,[8,9] lower birthweight[8-10] and lower IQ[9-11] — not necessarily concurrent with the full syndrome — have all been reported from studies of children of alcoholic mothers, including several that used matched control subjects.[9-11]

These risks have also been reported to increase

when women drink regularly or heavily during pregnancy, although they may not be "alcoholic" by the usual criteria. Alcohol, like most teratogens, gives rise to a spectrum of effects. Children with the fetal alcohol syndrome represent only one end of a range of outcomes associated with maternal alcohol abuse during pregnancy.[5-7] When the problems are apparently the result of exposure to alcohol in utero, the children are often said to have "fetal alcohol effects".[3,12] The range of effects linked to regular intake of alcohol by pregnant women varies not only in severity but also in type.

Growth decrements: Intrauterine growth retardation and decreases in birthweight by up to 493 g (compared with control infants) have been reported in the offspring of alcohol abusers.[10,13,14] The importance to fetal growth of drinking during late pregnancy has been documented by Rosett and colleagues.[15] Some, but not all, investigations dealing with "social" drinkers have also found lower birthweights in these drinkers' newborn infants. For example, there is a report of a 160-g decrease in birthweight independent of gestational age in the infants of women who consumed an average of two drinks* daily in the third trimester compared with infants whose mothers did not drink.[16] Other studies found no effect on growth when consumption was equal to or less than this.[17,18] There are several other investigations linking deficits in growth to consumption of alcohol in amounts generally below the level associated with alcoholism.[19-21] Most studies of intrauterine growth retardation have controlled for many relevant variables, and for smoking in particular.

The lower birthweights reported in these studies are not necessarily due to prematurity, since this variable is often controlled. Whether prematurity itself is linked to alcohol use is unclear, with some studies reporting a positive correlation[18,22] and others none at all.[14,20]

Major and minor malformations: There are several studies documenting an increased risk of anomalies with maternal alcohol use. Sokol and associates[14] have provided epidemiologic evidence that malformations are more frequent in children of alcohol abusers, supporting the conclusions suggested by clinical studies. At lower levels of consumption Hanson and coworkers[23] have noted an increased risk of abnormalities "suggestive of fetal alcohol syndrome" in moderate to heavy drinkers; 11% of women consuming an average of two to three drinks daily had children so affected, while 19% of infants were affected if their mothers had four drinks daily or more. Van den Berg[17] has also reported higher proportions of infants with anomalies born to women who had one or more drinks daily. Ouellette and collaborators[19] noted that 32% of infants born to "heavy" drinkers (at least one and a half drinks daily, and at least five on occasion) exhibited major or minor malformations. On the other hand, at least two studies failed to find an increased risk of anomalies at moderate to heavy levels of drinking.[18,20]

Mental, motor and behavioural effects: Alcohol consumption in moderate to heavy amounts has been associated with hypotonia, jitteriness, decreased stimulus habituation, tremulousness and decreased bodily vigour in the neonate.[19,24,25] Decreased operant learning has been noted in infants of women who both smoked and drank heavily during pregnancy.[26] Small but significant decrements in mental and motor development at 8 months have been reported in children whose mothers drank moderately during gestation (an average of two or more drinks daily).[27] At 4 years of age decreased attentiveness and social compliance, as well as increased fidgetiness, was apparent in children of another sample of women who drank moderately.[28]

Fetal wastage and perinatal death: Spontaneous abortion apparently occurs more frequently among alcohol abusers and even among moderate drinkers.[29,30] Investigations on both the east and west coasts of the United States have reported results that are in agreement: one to two drinks daily in a California study and drinking twice a week or more in New York City was associated with increases in the risk of spontaneous abortion during pregnancy, even after the results were controlled for numerous other relevant variables.

Increased risk of later fetal death and of perinatal death has been reported in studies of women consuming amounts ranging from three drinks daily[20] to very large amounts of alcohol.[9] The former study found that the stillbirths that were associated with drinking were due in most cases to abruptio placentae. An increased frequency of this condition has been reported by others,[14] though an increased rate of perinatal death was not apparent.

Other effects on the fetus: Other adverse outcomes of pregnancy have also been linked to alcohol consumption and abuse. Decreased Apgar scores in neonates have been associated with moderate to heavy drinking by the mother during gestation,[14,31] as has decreased placental weight.[20] Sucking frequency and amplitude may be reduced, even in infants of relatively moderate drinkers,[19,32] and this may contribute to the failure to thrive noted in children with the fetal alcohol syndrome. Finally, altered regulation of sleep–awake states and complications of pregnancy have been documented when alcohol consumption was heavy.[14,33]

Alcohol associated with a continuum of effects

In summary, if we consider the whole range of alcohol consumption — from one or two drinks daily to alcoholism — a continuum of effects on the fetus or infant can be visualized, with increasingly severe outcomes generally associated with increasing degree of alcohol use or abuse by the mothers. At the more severe end of the continuum is the fetal alcohol syn-

*A drink is defined as the volume of an American beverage containing 12 g or 15 ml (0.5 [American] oz) of absolute alcohol; this amount of alcohol is contained in 360 ml (12 oz) of beer, 120 ml (4 oz) of wine or 36 ml (1.2 oz) of 80-proof (40% alcohol by volume) liquor. In Canada a drink is defined as the volume of a Canadian beverage containing 13.6 g or 17 ml (0.6 [Imperial] oz) of absolute alcohol; this amount is contained in 340 ml (12 oz) of beer, 142 ml (5 oz) of wine or 43 ml (1.5 oz) of 80-proof liquor.

drome and its long-term consequences associated with maternal alcoholism. At the other end of the continuum are the effects associated with moderate drinking, which may not have long-term implications for the individual child. Thus, as with other teratogens, we see not only a continuum of outcomes, but also a dose–response curve for some outcomes. The configuration of the continuum will undoubtedly change as further studies are reported. In general, however, the effects that are most debilitating to the surviving child are associated with the heaviest and most chronic use of alcohol. These conclusions are consistent with those from research on laboratory animals that has been reviewed elsewhere.[25,34]

Relation of fetal alcohol effects to other risk factors

A review of the cases of the fetal alcohol syndrome reported in the world literature confirms our clinical impression that children with this syndrome are usually born to women with chronic alcoholism who drank heavily for several years before as well as during the pregnancy. A case has been reported of a child with this syndrome born to an alcoholic woman who had allegedly been abstinent during her pregnancy,[35] but the report has been criticized on the grounds of inaccurate diagnosis of the child's condition.[36] On the other hand, many alcoholic women bear children who apparently are not affected seriously by alcohol exposure in utero.

There is little evidence on factors that exacerbate or mediate the effect of alcohol on the fetus. The impact on a specific fetus may depend on the dose, concentration and timing of exposure to alcohol, as well as on a host of other factors, including maternal and fetal metabolism of alcohol. Nutrient intake and availability, use of other drugs and the presence of factors associated with poverty may also mediate or intensify the effect; research on these associated variables is continuing.

Two studies from Germany have addressed the issue of maternal antecedents of the fetal alcohol syndrome.[5,37] Both studies concluded that the risk of producing a child with the fetal alcohol syndrome is highest for mothers who are in the advanced stages of alcoholism (the "chronic" phase, according to Jellinek's criteria[38]). The risk appears to be much lower for women in the earlier stages of alcoholism. More studies with larger samples are needed before the levels of risk of the fetal alcohol syndrome among offspring of alcoholic women can be stated with certainty.

Epidemiologic and experimental studies of fetal alcohol effects have attempted to control for many potentially confounding variables. Smoking is perhaps the most worrisome because it is highly correlated with alcohol use, and because earlier studies showed smoking to be associated with an increased frequency of some of the same outcomes, such as stillbirth, spontaneous abortion and growth deficiency. However, most of the studies already cited[10,11,14-16,18,20-22,24,26-32] have controlled for smoking in the experimental design or adjusted for smoking in the statistical analysis. Several of these investigations determined that tobacco and alcohol use are separate risk factors for these outcomes.

The use of other drugs, which is known to be positively associated with alcohol use, is a problem less frequently addressed. In our own longitudinal prospective studies self-reported data on the use of other drugs and medications have been obtained. Although the use of illicit drugs and drugs suspected of being teratogenic was low in the Seattle studies and did not appear to bias the results, sorting out the effects of drug interaction may be more difficult in studies of high-risk inner-city mothers. Self-reported nutritional intake has been examined in only two studies[19,27] and did not appear to correlate with alcohol intake, although problems with measurement of nutritional intake may have existed. Other maternal risk factors, such as parity and socioeconomic status, have been controlled in some studies but not in others. Clearly these are important variables that must be considered in assessing both the outcome of pregnancy and long-term developmental consequences.

The studies on the consequences of alcohol use during pregnancy have suggested a wide range of outcomes associated with maternal alcoholism and with varying levels of maternal alcohol consumption. Some of the studies have been replicated, others have not. They have been conducted on samples that represent the general population in varying degrees. Some, but not all, have adjusted for several important confounding variables; most have adjusted for maternal smoking. Comparison of the methodologic details of these studies has been reported elsewhere.[25]

"Safe" levels of alcohol consumption in pregnancy

A frequent question that arises is whether a level exists below which drinking during pregnancy is without risk. The many methodologic problems involved in obtaining accurate assessments of amounts of alcohol consumed over the 9 months of pregnancy should preclude attempts to quantify the number of drinks per day that is either "safe" or definitely causes specific outcomes. All estimates of consumption are, at best, only approximations based on self-reports of unknown validity. Furthermore, many individual patterns of use are averaged to produce a score, such as average ounces of alcohol reportedly consumed per day. While these scores are useful for statistical analyses, they are probably not sufficiently precise to be taken as numerical values for computing risk. Thus, a specific "safe" level has not been identified, nor can exact probabilities of effects related to a given dose be calculated.

All the questions regarding alcohol and pregnancy have not been answered, and they should continue to be addressed both clinically and empirically. The impact of a single drinking binge is unknown. The risk of such an episode, especially before a woman realizes she is pregnant, is a question that continues to be of concern and poses problems in terms of planning intervention strategies. The exact mechanisms by which alcohol affects the embryo and fetus are

also under investigation. Is the direct effect of alcohol or the level of acetaldehyde, or both, responsible? The pathogenetic mechanisms that result in the fetal alcohol syndrome have been reviewed in detail elsewhere.[39]

Burden on the population of the effects of alcohol abuse during pregnancy

Three studies have now reported data on the incidence of the fetal alcohol syndrome.[8,23,40] The reported incidence of the syndrome (the most severe effects) ranged from 1 in 600 reported births in Sweden to 1 in 1000 births in France, with a figure of 1 in 750 births in the United States. Partial fetal alcohol effects occurred with about twice this frequency in the European studies. If we consider that infants with the syndrome have a high risk of being mentally retarded, then fetal alcohol syndrome would be the third most common type of mental retardation with a known cause. Unlike Down's syndrome and spina bifida, fetal alcohol syndrome is preventable. It is, however, more difficult to diagnose, especially at birth, and may be overlooked because the signs are less specific.

Determining the incidence of the fetal alcohol syndrome in only those infants whose mothers were alcoholic during their pregnancy is more difficult, because obtaining a random or unselected sample of alcoholic women is virtually impossible. The risk of a woman with chronic alcoholism producing a child with the fetal alcohol syndrome was estimated to be about 33% in one study of mothers of lower social class in the United States[9] and 43% in a German study.[37] Our own study of middle-class volunteers who recovered from alcoholism after the pregnancy yielded a rate of 4% of cases of the fetal alcohol syndrome.[10] As noted earlier, other risk factors may alter or intensify the teratogenicity of alcohol; until these are better understood it will not be clear to what extent the levels of risk reported in one study can be generalized to apply to another sample of alcoholic mothers.

The rate with which specific effects of alcohol on the fetus occur has not been determined. Some evidence is available, but the conclusions reached are based on numerous inferences and are therefore approximate at best. Furthermore, it is not known how much pregnant women are drinking at present and therefore what proportion of the pregnancies are at risk. Alcohol consumption may be lower now than it was at the time of the earlier studies, when there was less awareness of fetal alcohol effects.

In spite of these uncertainties, the state of New York has made a valiant attempt to determine the population burden of the effects of alcohol abuse during pregnancy.[41] If conservative incidence data are applied to the 233 328 live births that occurred in the state in 1978, 386 of those children were probably afflicted with the fetal alcohol syndrome, and an additional 1563 probably had other birth defects related to alcohol. The lifetime cost of caring for the children with the syndrome is estimated to be $66 million, and the cost for the children with other alcohol-related birth defects nearly $89 million. Thus, New York State projects a cost of $155 million incurred each year as a result of the birth of children with alcohol-related damage (given a constant number of live births and unchanged drinking patterns).

The estimates made by the state of New York pertain only to the cost of education and of medical and custodial care, and do not take account of the possible need for foster placement when an alcohol-abusing mother is unable to provide an adequate home for her child. Excluded also is the unmeasurable cost of decreased potential for achievement of children exposed to alcohol in utero. The figures for the economic cost of alcohol-related damage may be approximate and incomplete, but they are sufficient to convince anyone that drinking regularly during pregnancy is a habit that is expensive to the mother, to the child and to the society in which they live.

Strategies for preventing the adverse effects of alcohol on the fetus

Even though all the scientific questions have not been answered, the cumulative evidence from the many studies reviewed warrants the conclusion that it is better for infants if their mothers do not drink during pregnancy. One important question is how to disseminate this message.

A demonstration project to develop strategies for preventing the fetal alcohol syndrome and for intervening in alcohol abuse during pregnancy, called the Pregnancy and Health Program, has been under way in Seattle for over 2 years.[42] Strategies for prevention and intervention have been developed in three directions.

Public education

Heightened public awareness of the risks that alcohol presents to the fetus is clearly needed. This need has been addressed by the Pregnancy and Health Program in three ways: by presentations in the media, by distribution of written and audiovisual materials, and by personal contact. Media messages are transmitted by television, radio and newspaper. Public service announcements are particularly effective, especially when the format is changed frequently. Guest appearances of program professionals on "talk" shows, especially those where the listener may call in, are well received. These are powerful but expensive public education tools. Brochures, posters and audiovisual materials are less expensive; their effectiveness depends on the breadth of their distribution. Program administrators have found that signs in public buses catch the eyes of a large captive audience. Brochures and posters are given wide exposure by being displayed in innovative ways (in laundromats, liquor stores and marriage licence bureaus; for example). Businesses with cooperative personnel have often assisted by distributing brochures with their product or including them in a mailing. A slide–tape show will be used in schools and professional offices. Finally, the program staff have established personal contact by making

public appearances before large audiences; smaller audiences reduce the cost-effectiveness of this approach, but staffing a booth at a large health fair, for example, will reach many persons.

The effectiveness of a public education campaign will be strongly influenced by the quality of the personnel involved and the materials presented. Talented graphic designers, expert printers, professionally trained speakers — all are an investment in effectiveness. Having shoddy, inaccurate materials and inept personnel is worse than having no program at all, for they detract from the credibility of the message.

The message in the Pregnancy and Health Program public education campaign has been simple and direct: abstinence is the safest course of action during pregnancy. The decision to recommend abstinence was based partially on a population survey conducted before starting the program. This survey revealed that a significant proportion of persons who were aware of fetal alcohol effects still felt that a daily average of three drinks during pregnancy was safe.[43] Furthermore, beer and wine were regarded as safer than hard liquor. Thus, public education materials have stressed that the usual servings of beer, wine and liquor all contain approximately the same amount of alcohol.

Husbands, parents and children, in addition to pregnant women, all need information about alcohol and pregnancy. This information needs to be part of the general knowledge of the populace, not just a specific aspect of prenatal information transmitted to pregnant women at their first prenatal visit. The goal of public education in this area should be not only to inform, but to create a climate of opinion in which abstinence during pregnancy is socially accepted behaviour. Women will often do more for their children than they will for themselves. Forgoing alcoholic beverages for 9 months may not seem difficult to the woman who wants a healthy child, especially since the appetite for alcohol wanes during pregnancy.[44,45] It will be easier, however, if family and friends endorse this decision and provide a support system for the woman who is changing her drinking habits.

Professional education

Professionals, particularly physicians, nurses, social workers, psychiatrists, teachers and alcohol counsellors, need to be knowledgeable about the effects of alcohol on the outcome of pregnancy. There are several ways to reach such persons. The continuing education requirement of many professions makes the presentation of workshops that confer credits an attractive option. Hospitals that must offer continuing education to their staff to maintain accreditation usually welcome a well conducted seminar. Most agencies staffed by health professionals have in-service training programs that provide additional opportunities. To reach students, inclusion of relevant material in the curriculum is essential.

Health professionals are a more critical audience than the lay public. Again, the quality of the presentation and the credibility of the speaker will determine the effectiveness of the effort. For these audiences the message need not be as simple, but it must be accurate and well organized, and appropriate documentation must be ready for those who request it. In our experience, written materials have been useful only as a secondary source of information, because most health professionals have little time to read them. Most effective is personal contact with one of their own discipline who can present information in a way that is relevant to the specific profession. Thus, nurses train nurses, physicians train physicians; in general the speaker is matched to the audience as far as possible.

Initially there may be scepticism about the degree of risk attached to drinking during pregnancy, especially among health providers whose training is not recent. The great explosion of information on this topic over the past 8 years means that few health care professionals have received training in the fetal risks associated with maternal use of alcohol. Updating of curricula in schools of medicine, nursing, public health, clinical psychology and social work is urgently needed.

Services to pregnant women

Information about alcohol as a hazard to the fetus should be a routine part of good prenatal care. This information should be given to all women, not just those who the physician thinks may have a drinking problem. Likewise, women of childbearing age receiving counselling for alcohol abuse should be made aware of the advisability of bringing their drinking under control before beginning a pregnancy. Educating professionals about alcohol and pregnancy will help to ensure that such information is accurately transmitted to patients and reinforced by the authority that accompanies advice dispensed by professional caregivers. The fear that women may be made anxious by such information is, in our opinion, a poor excuse for failing to provide it. Experience in the Pregnancy and Health Program indicates that most women welcome the opportunity to obtain an accurate assessment of the risks of alcohol consumption during pregnancy. Health and helping professionals may use this as an ideal opportunity to resolve any concerns that already exist. A special crisis line for dispensing information on alcohol and pregnancy has been well used in Seattle. The concern of a skilled caregiver may accomplish the same end, allaying fears and encouraging women to enhance their health in the remaining months of pregnancy.

In conclusion, great strides have been made in the past 8 years in understanding the adverse effects of intrauterine exposure to alcohol. The scientific evidence is incomplete, however, so research in this important area must continue. But alcohol is a known teratogen and, like other drugs with known or suspected teratogenic properties, its use is contraindicated during pregnancy.

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Books

This list is an acknowledgement of books received. It does not preclude review at a later date.

CANCER RISKS BY SITE. UICC Technical Report Series — Volume 41. Edited by Takeski Hirayama, John A.H. Waterhouse and Joseph F. Fraumeni, Jr. 217 pp. Illust. International Union Against Cancer, Geneva, 1980. $12.39, paperbound. ISBN 92-9018-041-2

CURRENT THERAPY 1981. Latest Approved Methods of Treatment for the Practicing Physician. Edited by Howard F. Conn. 1055 pp. Illust. W.B. Saunders Company Canada Limited, Toronto, 1981. $40.80 (Can.). ISBN 0-7216-2709-9

FRONTIERS OF RADIATION THERAPY AND ONCOLOGY. Vol. 15. Pharmaceutical Aspects of Cancer Care. 15th Annual San Francisco Cancer Symposium, San Francisco, Calif., March 15–16, 1980. Edited by Jerome M. Vaeth. 183 pp. Illust. S. Karger AG, Basel, 1981. $78. ISBN 3-8055-1512-X

GERIATRIC DERMATOLOGY. G.W. Korting. Translated by William Curth and Helen Ollendorff Durth. 194 pp. Illust. W.B. Saunders Company Canada, Ltd., Toronto, 1980. $49.35 (Can.). ISBN 0-7216-5495-9

INTRODUCTION TO ABDOMINAL SURGERY. Fifty Clinical Studies. Clarence J. Schein. 521 pp. Illust. Harper & Row, Publishers, Inc., Hagerstown, Maryland, 1981. $30. ISBN 0-06-142381-5

LAY REPORTING OF HEALTH INFORMATION. World Health Organization. 27 pp. Illust. World Health Organization, Geneva, 1978. $2.60, paperbound. ISBN 92-4-154134-2

LOW BACK PAIN. Volume 2. R. Grahame and J.A.D. Anderson. 83 pp. Eden Press, Westmount, PQ, 1980. $14. ISBN 0-88831-095-1

A NEW LOOK AT SENILITY. Its Causes, Diagnosis, Treatment, and Management. Albert A. Fisk. 103 pp. Illust. Charles C Thomas, Publisher, Springfield, Illinois, 1981. $11.75, paperbound. ISBN 0-398-04436-8

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